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Innovation in London

By Rachel Wilson

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1. Executive Summary

This paper discusses an apparent paradox with regards to London's economy. Productivity in London is the highest of all the UK regions. In 2005 GVA per worker in London was 17.7 per cent higher than in the next most productive region, the South East, and 22.5 per cent higher than the UK average.[1] However, according to central government's measures of innovation, London's innovation performance is mixed. Given that economic theory suggests a positive relationship between innovation and productivity, London's seemingly contradictory performance against these two sets of indicators raises questions about the nature of innovative activity in the region.

In measuring innovation across the regions, central government identifies four indicators. On two of these, business enterprise research and development, and gross expenditure on research and development, London performs very badly compared to the other regions. On the other two measures, the proportion of firms with co-operation agreements on innovation, and the percentage of turnover that is accounted for by new or significantly improved products, London performs relatively well. In fact, on the last of these measures, London outperforms all of the other UK regions by a considerable margin.

This paper distinguishes between input and output measures of innovation. Business enterprise research and development, gross expenditure on research and development and co-operation agreements are all measures of inputs to the innovation process. The percentage of turnover accounted for by new or significantly improved products is a measure of the output from the innovation process.

One of the principle reasons why central government is interested in the level of innovation in each of the regions is because of the identification of innovation as a driver of productivity. Since it is the outputs of innovation that ultimately feed through to increases in productivity, London's weaker performance against input measures might be of less concern. However, understanding why London appears to perform poorly on the input measures of innovation could be instructive in better understanding London's innovation performance, especially as it relates to policy making.

It is argued that central government's measures of innovation, in particular the input measures, do not capture all innovative activity undertaken in London because they are biased towards capturing innovation in manufacturing rather than services. In 2004, 91 per cent of all jobs in London were in services (broadly defined). The comparative figure for the rest of the UK was 80 per cent[2]. Given the extent of the dominance of the services sector in London relative to the

[1] Calculated by GLA Economics, based on GVA and employment data from Experian Business Strategies. Employment figures include self-employment.
[2] Analysis of employee jobs by broad industry group, data from the Annual Business Inquiry.

other regions of the UK, central government's measures of innovation are likely to be particularly poor at reflecting the true extent of innovation in London.

Innovation in services is likely to be driven to a large extent by the environment in which the business operates, rather than by specific measurable inputs such as investment in research and development. This environment is likely to be dynamic, driven by factors such as the number of competitors located within close geographical proximity, and the demands of the customer base. These types of concepts are relatively difficult to capture in simple input measures, thus leading to the difficulties of capturing inputs in to innovation in London.

This paper argues that it is very difficult to measure the inputs to innovation in services. Although a number of alternative measures of innovation, some input and some output measures, are suggested in this paper, for various reasons, use of these measures may not paint a full picture of innovation both within London and across the UK as a whole.

It is argued that in an increasingly services-dominated economy, the most effective way of capturing all innovative activity will be through survey measures. This is open to the caveat that the survey must define innovative activity in an open and explicit enough manner for all firms to interpret it in the same way.

In terms of understanding the extent of innovative activity in an economy, analysis of output measures, which will tend to be more accurate because of the difficulties in measuring inputs, will be most appropriate. It is understood however, that in terms of designing policy, it may well be necessary to have a better understanding of the inputs to the innovation process. With particular relevance to the London economy, this will mean gaining an appreciation of what creates the environment that encourages firms to innovate. There may well be a need for more research in to this area in order to ensure that these issues are fully understood.

2. Introduction

2.1 What is innovation and why is it important?

There are various definitions of innovation, but the one used for the purposes of this paper is "the successful exploitation of new ideas". New ideas themselves may take any number of forms, including new products and processes, new organisational techniques, new markets and new sources of supply[3].

Policy makers are concerned with innovation because of its importance in driving economic growth. The exploitation of new ideas allows for improvements in products and processes that lead to the economy working more efficiently. For instance, the idea of creating a production line of a number of workers with different specialisations led to huge increases in output for the same input: an improvement in productivity. Improvements in productivity may be passed on to the consumer in lower prices. They may also lead to an expansion of output, possibly creating greater demand for labour and so increasing employment. Higher productivity may also lead to lower costs and so greater profits for business. These can in turn be fed back through to investment in innovation, potentially creating more innovative goods and services.

2.2 The role of the public sector

It is clear that innovation is good for the economy. However, this alone is not a justification for government policies to encourage innovation. There is only a need for such policies if it can be shown that the market alone will not provide the optimal level of innovation. If this were the case, then the economic benefits outlined above might not be maximised, and so there might be a role for the public sector in increasing the amount of innovation undertaken.

In fact, economic theory *does* suggest that market forces alone will not lead to the optimal amount of innovation. This is because it is difficult for private actors, be they firms or individuals, to capture all of the benefits of their investment in innovation. The reason for this is the nature of knowledge, and the way that it may spill over to those that are not involved in paying for its creation. This is clarified with an example.

If a firm invests in creating a drug which cures liver disease, then it will make its decision as to how much to invest in the development of that drug according to the returns that it assesses it will make by selling the drug. However, once it has been created, the drug can be copied by other firms who are then able to market it themselves. This 'spillover' effect means that other firms are able to 'free-ride' on the investment, since they benefit from it without having to contribute to its cost.

[3] Frenz, M. and Oughton, C .(2005) 'Innovation in the UK Regions and Devolved Administrations: A Review of the Literature.'

These 'spillover' effects have two impacts on the investment decision of the firm. Firstly, since it is taking only the returns to itself, and not these wider returns in to account when deciding how much to invest in developing the drug, it will invest less than would be the case if it were taking all of the returns in to account. Second, if the firm is aware that it will not be able to capture all of the information that is created through its research, and that other firms will consequently be able to profit from it, then it will have a disincentive to invest in the research in the first place. These effects lead to an under-investment in research and development over time.

Both of these effects can be overcome with the use of patents, which allow firms to protect the information generated through research and development, thus capturing any potential spillover effects and ensuring that they are able to maximise the returns to their investment, without other firms free-riding on it.

There is a second spillover issue that patents are not able to overcome. In creating the drug against liver disease, the firm generates knowledge that was not previously in existence. It is possible that this knowledge can then be used for other, possibly unforeseen, uses, such as the creation of other new drugs for instance. If this is the case, then the contribution that the firm's research in to the liver drug has made to the body of knowledge is over and above that captured by the firm itself, even if it has a patent. This creates the same problems of under-investment that have been outlined above. This issue is outlined in a paper by the Institute for Fiscal Studies, which shows that because the private returns to investment in R&D are less than the social returns, there is under-investment in R&D.[4]

There may therefore be a role for the public sector in securing these wider economic benefits, by ensuring that there are incentives in place for individuals and firms to carry out innovative activities. In addition to the provision of patents, which may not secure all of these benefits for the reasons outlined above, this might include subsidising the innovation process, particularly in areas that are expected to have significant wider social benefits.

2.3 Innovation in London

In what follows, this paper considers the innovation performance of London. First it looks at the different measures of innovation currently used by the government and how London performs against them. The following section considers some of the reasons behind the difference in innovation performance between regions, including an analysis of industrial structure and the differences in the nature of innovative activity across industries. The paper concludes by providing some alternative measures of innovation that might better capture innovative activity and by suggesting the policy implications of the analysis.

[4] See: Institute for Fiscal Studies (2000) 'How Important is Business R&D for Economic Growth and Should the Government Subsidise it?' Briefing Note No 12

3. London's performance against the government's measures of innovation

3.1 Government indicators

Innovation has been identified by the government as one of the key drivers of productivity at the regional and national level. This is in line with the wider economic benefits resulting from innovation that were set out in the introduction. In fact, the government has identified a number of drivers of productivity, as well as indicators against which to measure their performance. These are outlined below.

Productivity

- Gross Value Added (GVA) per worker and per hour

Drivers of productivity:

Investment

- Business investment as a percentage of GVA by broad sector for UK and foreign-owned companies

Innovation

- Business Enterprise Research and Development as a percentage of GVA
- Gross Domestic Expenditure on Research and Development as a percentage of GVA
- Proportion of enterprises with co-operation arrangements on technological innovation activities with other enterprises or institutions
- Proportion of sales accounted for by new or improved products

Skills

- Highest qualifications of adults
- 16/19 year olds qualified to NVQ Level 2 and 19/21 year olds qualified to NVQ Levels 2 and 3
- Proportion of employees receiving training in last four weeks

Enterprise

- Total entrepreneurial activity
- Business start-ups (VAT registrations) per 10,000 adult population

Competition

- Exports as a percentage of GVA

All of the above indicators are being monitored by the government[5] in order to help judge progress against Public Service Agreement (PSA) targets.

In addition to the regional indicators outlined above, the government uses two additional indicators for international comparisons of innovation. The first is 'publications and citations of research in academic journals', which is designed to provide an indication of the strength and effectiveness of the science base in the UK[6]. The second is 'patents granted in the US Patent and Trademark Office'. Patents are a measure of immediate output from the innovation process, and so are effective at capturing innovation particularly in those sectors that carry out formal R&D[7].

In what follows, the paper focuses on the four regional indicators of innovation, against each of which London's performance is assessed.

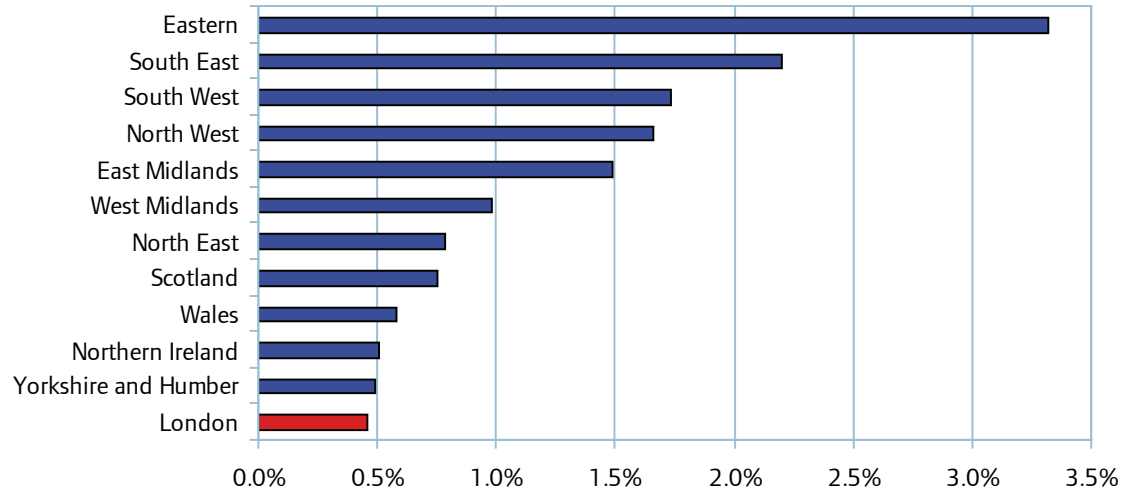
3.1.1 Business Enterprise Research and Development as a percentage of GVA

Data on Business Enterprise Research and Development is gathered by the Office for National Statistics on an annual basis. The survey that is sent to firms in order to collect the data states that 'the guiding line to distinguish R&D activity from non-research activity is the presence or absence of an appreciable element of novelty or innovation.'[8] Business Enterprise Research and Development is an *input* measure of innovation, since it looks at the money that firms are putting in to generating knowledge, rather than the outputs of that process.

Figure 1 illustrates that compared to the other UK regions, London had the lowest expenditure on business enterprise research and development (R&D) as a percentage of workplace GVA in 2004 (0.5 per cent). The Eastern region had by far the highest expenditure of 3.3 per cent, followed by the South East with 2.2 per cent.

[5] http://www.iggi.gov.uk/regind/default.asp.
[6] DTI (2004) 'Benchmarking UK productivity performance: The Government's response to the consultation on productivity indicators.' p12
[7] DTI (2006) 'UK Productivity and Competitiveness Indicators' Economics Paper No. 17
[8] Rogers, M (2006) 'Estimating the Impact of R & D on productivity using the BERD-ARD data.' p7

Figure 1: Business enterprise R&D as a percentage of GVA 2004



Source: Office for National Statistics

3.1.2 Gross Domestic Expenditure on Research and Development as a percentage of GVA

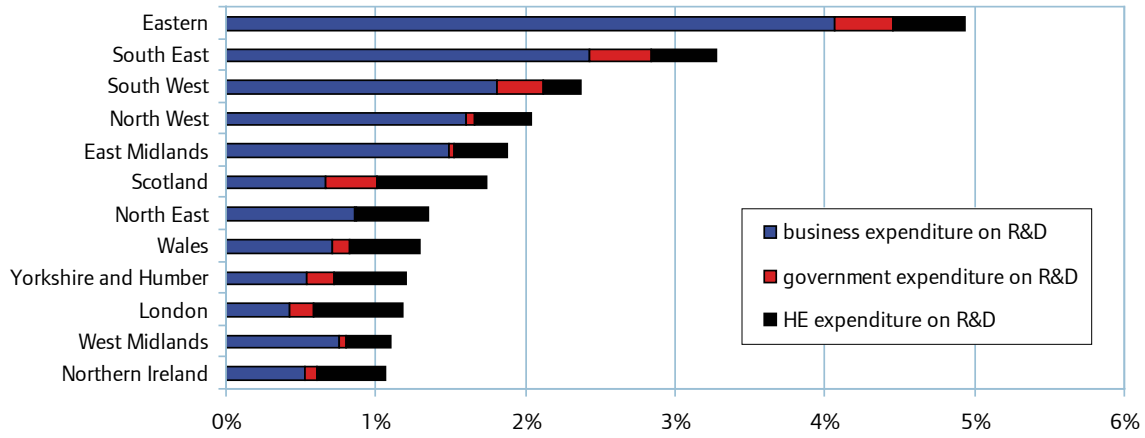
Gross Domestic Expenditure on R&D is divided into four economic sectors: business, government, higher education institutions, and the Private Non-Profit (PNP) sector. However, at the regional level, data from the PNP sector is unavailable and therefore not included in this analysis[9]. As with Business Enterprise Research and Development, Gross Domestic Expenditure on Research and Development is an input measure.

As Figure 2 shows, London's gross domestic expenditure on R&D as a percentage of GVA was the third lowest of the UK regions in 2003 (1.2 per cent).

However, breaking this expenditure down in to its component parts paints a slightly different picture of R&D in London. As noted earlier, business expenditure on R&D as a percentage of GVA is lowest in London. However, higher education expenditure in London as a percentage of GVA is the second highest of all the UK regions (0.6 per cent). In addition, although Government expenditure on R&D as a percentage of GVA in London is slightly below the national average (0.16 per cent as compared with 0.20 per cent for the UK as a whole) London performs better than a number of other regions on this measure.

[9] This is of little significance since R&D in the Private Non-Profit sector represents only a fractional share of total R&D expenditure – in 2004 it made up 3.33 per cent of gross expenditure on R&D– see Office for National Statistics (2006) 'Gross Domestic Expenditure on Research and Development.' First Release.

Figure 2: Business, Government and HE expenditure on R&D as a percentage of GVA, 2003



Source: Office for National Statistics

3.1.3 Proportion of enterprises with co-operation arrangements on technological innovation activities with other enterprises or institutions

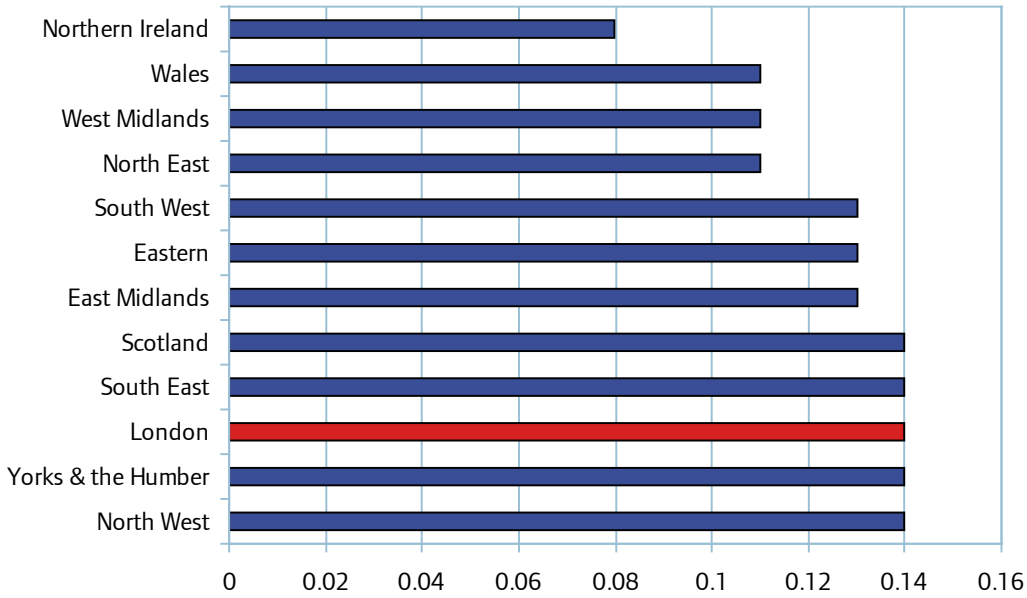
Co-operation agreements on innovation exist when two or more organisations are actively participating jointly in innovation activities. They can be between enterprises or non-commercial institutions or a mixture of the two.[10] They are one way in which firms can gain access to knowledge and resources that are inputs to the innovation process. As such, this is another input measure.

Co-operation arrangements are a useful indicator since they are likely to reflect the effectiveness of national or regional government policies to promote innovation through the establishment of technology networks and business-university collaboration schemes.

Evidence from the fourth Community Innovation Survey (CIS4) shows that of those firms that have co-operation arrangements of some kind, more collaborate with their suppliers and customers than with their competitors, universities or government institutions.[11]

[10] See question 17 of the questionnaire of the Fourth Community Innovation Survey for an explanation of what to consider as a co-operation arrangement. Found at: http://www.dti.gov.uk/files/file9688.pdf
[11] See DTI (2006) 'Innovation in the UK: Indicators and Insights.' p26

Figure 3: Firms that had co-operation agreements on innovation between 2002 and 2004, as a percentage of all firms in the region



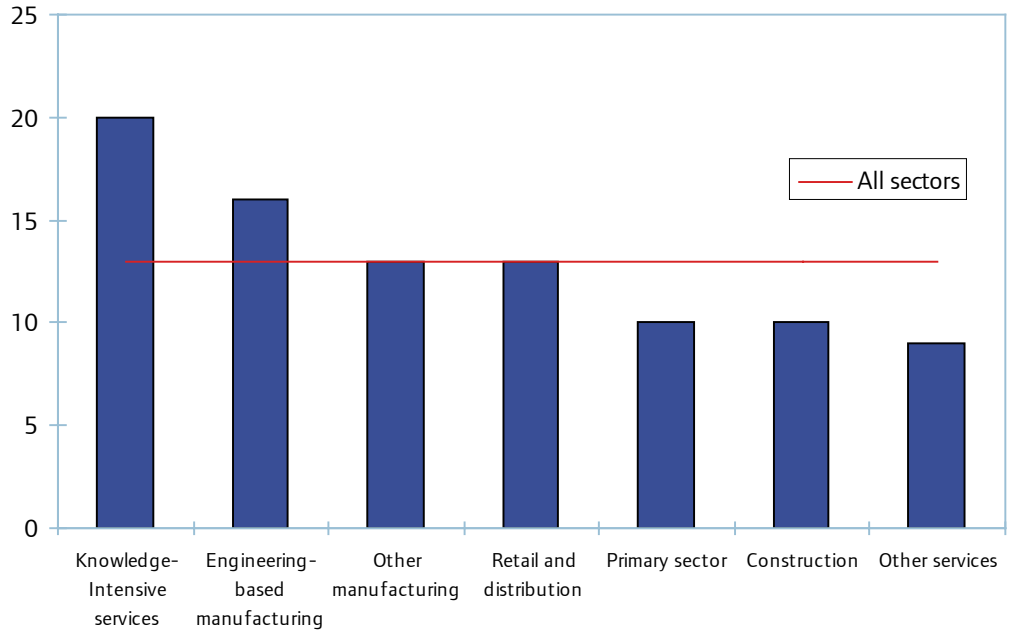
Source: Department for Trade and Industry/Fourth Community Innovation Survey [12]

Figure 3 shows that over the period 2002-2004 the proportion of all firms with co-operation arrangements on innovation was as high in London as in any other region of the UK, although the variation between regions was not huge. This may be partly explained by Figure 4, which shows that the knowledge intensive services[13] sector has the greatest proportion of all firms entering co-operation agreements.

[12] DTI (2006) 'Innovation in the UK.' DTI Occasional Paper Number 6 – statistical index. Available at http://www.dti.gov.uk/files/file33016.xls

[13] For the purposes of this analysis, 'knowledge-intensive services' includes the following sub-sectors: telecommunications, financial intermediation, computer and related services, research and development, legal, accounting, book-keeping and auditing activities, tax consultancy, market research and public opinion polling, business and management consultancy, holdings, architectural and engineering activities, and related technical consultancy, technical testing and analysis and advertising.

Figure 4: Percentage of firms within each sector which had cooperation agreements on innovation between 2002 and 2004



Source: Department for Trade and Industry/Fourth Community Innovation Survey [14]

In terms of who the firms are co-operating with, the greatest proportion of firms in the knowledge intensive services sector reports co-operating with suppliers (73 per cent) as being most important with the next most important partner being customers (71 per cent). These are the two most important partners for firms in *all* of the sectors studied.

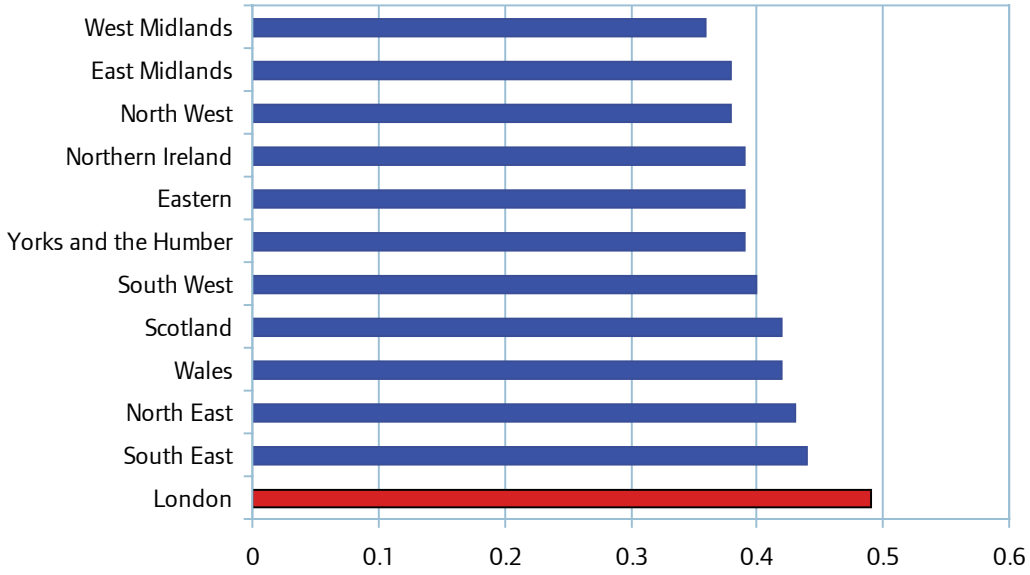
Firms with co-operation arrangements on innovation are known to represent a relatively small proportion of all innovators. The UK CIS4 recorded innovation activities amongst 57 per cent of firms in the period 2002-2004, but co-operation arrangements on innovation amongst just 13 per cent[15]. Given this, alongside the fact that the variation in performance against this measure is actually fairly narrow, as shown in Figure 3, it would be unwise to conclude from this measure alone that London's innovation performance is much better than is suggested by the previous two measures.

[14] DTI (2006) 'Innovation in the UK.' DTI Occasional Paper Number 6 – statistical index. Available at http://www.dti.gov.uk/files/file33016.xls
[15] DTI (2006) 'Innovation in the UK.' DTI Occasional Paper Number 6 – statistical index. Available at http://www.dti.gov.uk/files/file33016.xls

3.1.4 Proportion of sales accounted for by new or improved products

Figure 5 shows that for London's firms, 49 per cent of turnover is accounted for by goods or services that have been significantly improved or are new to the firm.[16] This is higher than any of the other regions, and suggests a very different conclusion as to the extent of innovative activity in London than does performance against the expenditure on R&D measures discussed.

Figure 5: Percentage of turnover from products new to the firm or significantly improved



Source: Department for Trade and Industry/Fourth Community Innovation Survey[17]

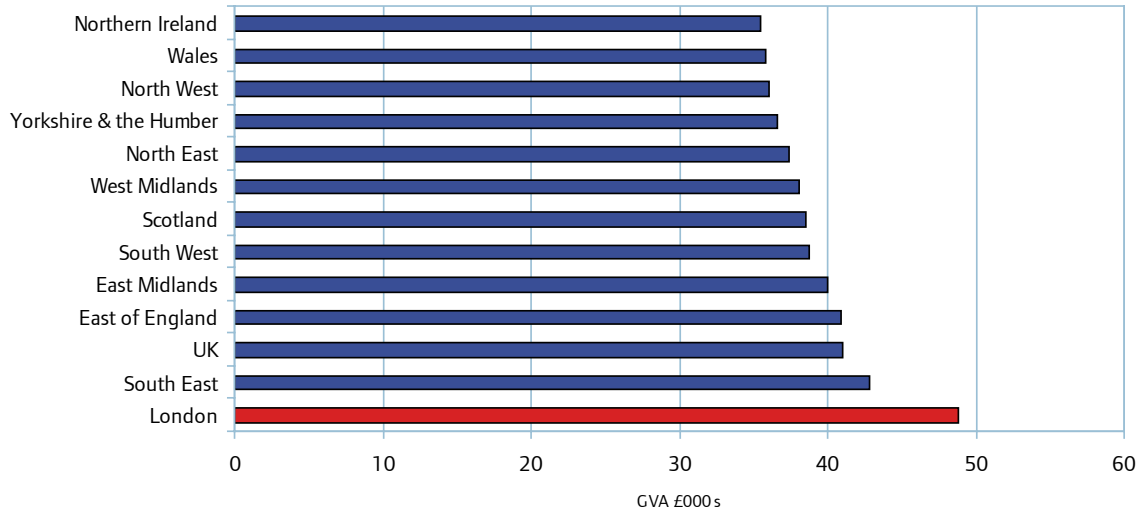
It is suggested that London's strong performance against this indicator is due to its industrial structure.[18] Of all of the sectors analysed as part of CIS4, knowledge intensive services was the best performer against this measure, with 58 per cent of turnover being from products significantly improved or new to the firm.

[16] See question 6 of the questionnaire for the Fourth Community Innovation Survey for what is included in new or significantly improved 'products'. Found at: http://www.dti.gov.uk/files/file9688.pdf
[17] DTI (2006) 'Innovation in the UK.' DTI Occasional Paper Number 6 – statistical index. Available at http://www.dti.gov.uk/files/file33016.xls
[18] DTI (2006) ''Innovation in the UK.' DTI Occasional Paper Number 6. p15

3.1.5 London's innovation performance

In summary, London's performance against the government's measures of innovation is mixed. It ranks badly, if not the worst, on two of the four measures. However, it performs more strongly on the third measure, concerning co-operation agreements, and outperforms all other regions of the UK in percentage turnover from products that are new to the firm or significantly improved. Importantly, in terms of the distinctions that are made further on in this paper, the measures against which London has a poor, or unclear performance, are measures of inputs to the innovation process. The one measure against which it performs very well, concerns outputs from the innovation process. Moreover, London outperforms all of the other regions of the UK in terms of productivity, measured in terms of GVA per worker, as shown in Figure 6.

Figure 6: Regional productivity, GVA per worker £000s, 2005



Source: GLA Economics' calculations based on data from Experian Business Strategies[19]

As such, the paradox regarding London's innovation performance has two parts. The first is that although London performs poorly on measures of *inputs* into the innovation process, it actually performs very well against the government's only measure of the *outputs* of innovation: percentage of turnover from products new to the firm or significantly improved. The second, already alluded to, is that given London's mixed overall innovation performance (taking all of the government's indicators into account), economic theory would suggest that it would also have a poor productivity performance relative to the other regions of the UK; however, this is not the case.

[19] Both GVA and employment figures used here are on a workplace basis. Employment figures include self-employment

The first part of this paradox is important since it is ultimately the *outputs* of innovation that are of interest in terms of the link between innovation and productivity: it is the new products, new processes and new ways of working which will lead to higher productivity, rather than the inputs to the innovation process themselves. The inputs are only important in as much as they lead to outputs. As such, the first part of the paradox seems to go some way towards explaining the second: a high level of innovation output is conducive with a strong productivity performance.

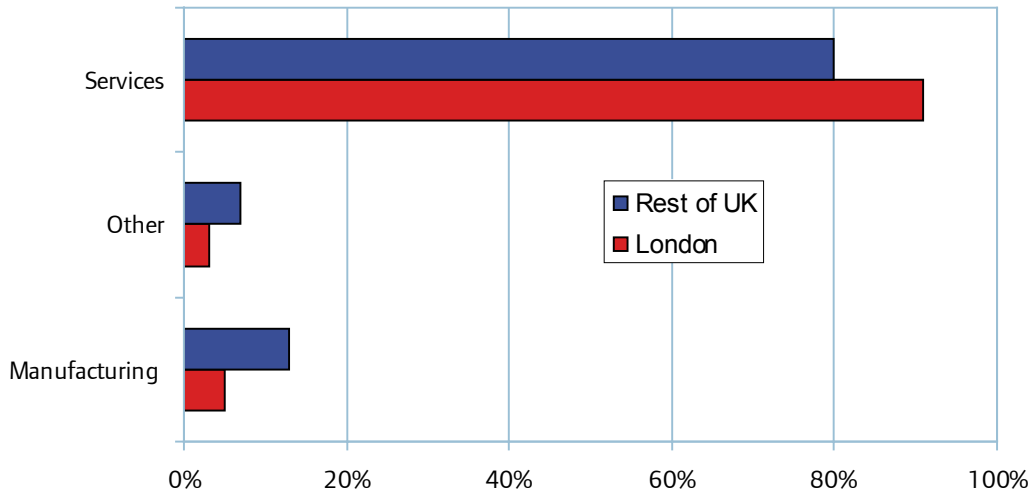
4. Understanding London's innovation performance

4.1 The nature of innovative activity in London

This section argues that there is no fundamental contradiction between London's mixed performance against the government's innovation measures and its high level of productivity. Rather, those measures fail to capture the full extent of innovation in the region, largely because of its industrial structure. Research that has been undertaken comparing the innovation performance of the UK with that of other countries in the EU has reached a similar conclusion with regards to the underperformance of the UK as a whole against traditional measures of innovation.[20]

The main argument underpinning the reasons for which the current indicators are a poor measure of innovation in London concerns the extent to which the indicators are suited to capturing innovation in the services industry.

Figure 7: Employee jobs by broad sector, as a percentage of all jobs in the region, 2004



Source: Annual Business Inquiry[21]

Figure 7 illustrates the importance of the service sector for London's economy, as compared with other regions of the UK. It shows that the service sector (broadly defined, see footnote 21) accounts for 91 per cent of employment in London, as compared with 80 per cent for the rest of

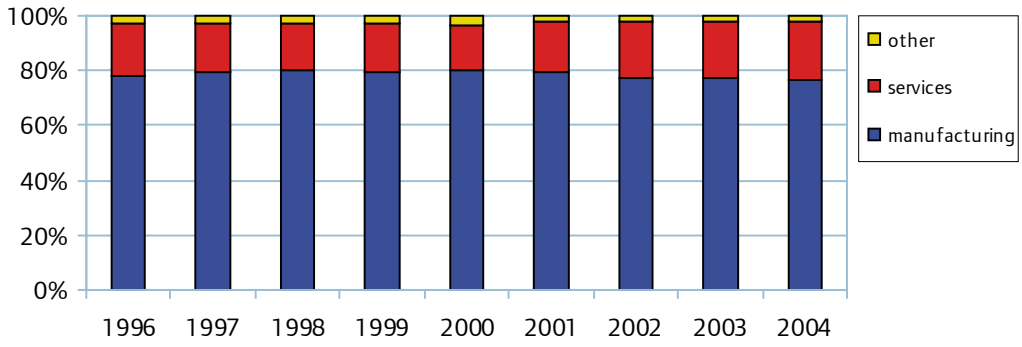
[20] See: NESTA (2006) 'The Innovation Gap: Why Policy Needs to Reflect the Quality of Innovation in the UK.' Research report, October.

[21] The three broad sector groups have been constructed to match those used by the Office for National Statistics in 'Research and Development in UK Businesses, 2004 (MA14).' Table 1A (used in figure 8). This adopts a broad definition of the services sector, including public administration, wholesale and retail trade and transport, together with the more obvious service sectors.

the UK. In contrast, whilst manufacturing accounts for 13 per cent of employment in the rest of the UK, it accounts for only five per cent of employment in London. Therefore it is clear that although the service sector dominates employment *throughout* the UK, this is the case to a larger extent in London than elsewhere. This is important because of the different nature of innovative activity in the manufacturing and services industries. It has been suggested that although innovation in manufacturing tends to take a step approach, whereby one innovation is made, followed by subsequent future innovations, innovation in the service industry tends to take the form of more continuous change[22]. As a result, firms in the service industry are less likely to rely on R&D as a driver of innovation[23]. Therefore, although UK innovation surveys suggest that R&D typically accounts for around 40 per cent of innovation expenditures[24], this percentage is likely to be lower for London given the structure of its economy.

Analysis of business R&D expenditure reveals that it is very much concentrated in manufacturing rather than service sector firms. Figure 8 shows expenditure on R&D performed in UK businesses for the period 1996-2004. It illustrates that over that period, by far the greatest proportion of all business expenditure on R&D was carried out in manufacturing.

Figure 8: Expenditure on R&D in UK businesses 1996-2004, in real terms



Source: GLA Economics' calculations based on data from the Office for National Statistics[25]

Within the manufacturing sector, certain industries dominate business enterprise R&D. In particular, pharmaceuticals and aerospace account for a significant proportion of all spending. In 2004, these two sub sectors accounted for over 38.8 per cent of total business expenditure on R&D in the UK[26].

It therefore seems clear that when innovation is measured using business expenditure on R&D, London's performance will not necessarily be measured effectively.

[22] Tether, B (2004). 'Do services innovate (differently)?' Centre for Research on Innovation and Competition Discussion Paper No 66.
[23] OECD (2004) 'Promoting Innovation in Services.'
[24] DTI (2005) 'R&D Intensive Businesses in the UK.' Economics Paper No.11
[25] Office for National Statistics (2005) 'Research and Development in UK Businesses, 2004 (MA14).' Table 1A
[26] Office for National Statistics (2005) 'Research and Development in UK Businesses, 2004 (MA14).' Table 2.

4.2 Testing the hypothesis: the use of survey methods

It is argued that survey methods may be more effective at capturing innovation in the services sector, since they are able to ask more qualitative questions and as such may capture a wider variety of activities. It is clear, however, that this will depend crucially on the definitions of innovation used in the survey documents, and the extent to which all firms interpret them as being relevant to their own activities.

This issue was considered in the design of the London Annual Business Survey (LABS) 2005.[27] The questionnaire was designed in a way that allowed for differentiation between product and process innovation. Product innovation was defined as the creation of new products and/or modifications to existing products. Process innovation was defined as introducing new equipment and/or new working methods.

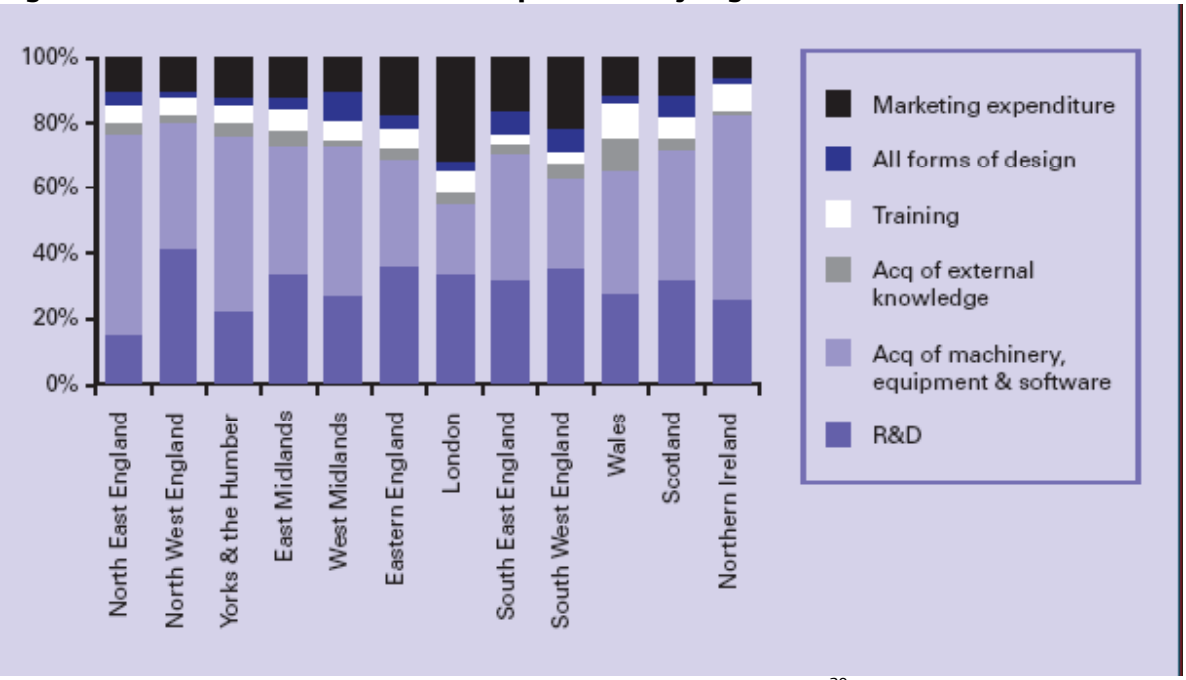
The results suggest that the service sector is involved in both process and product innovation. The 2005 survey found that 41 per cent of business and professional services firms carry out both product and process innovation, compared with just four per cent of 'other manufacturing' firms.

Data from the Fourth Community Innovation Survey (CIS4)[28] provides further evidence of the nature of innovation in London. Figure 9, taken from that survey, breaks down innovation expenditure in each of the regions of the UK.

In line with the argument that a lot of innovation in the services sector is about responding to changes in market conditions, Figure 9 shows that as a proportion of innovation expenditure, marketing is much more important in London than in other regions.

[27] London Development Agency 'The London Annual Business Survey 2005' which can be found at http://www.lda.gov.uk/server/show/ConWebDoc.1711
[28] DTI (2006) 'Innovation in the UK: Indicators and Insights.'

Figure 9: Breakdown of innovation expenditure by region



Source: Department for Trade and Industry/Fourth Community Innovation Survey[29]

Table 1 illustrates the type of innovative activity that was being undertaken in each of the regions of the UK over the period 2002-2004, as a percentage of all innovation being undertaken in the region.

In order to interpret the figure, and what it illustrates about the nature of innovation in London as compared to elsewhere in the UK, it is necessary to understand what is meant by each of the different concepts used in the table, for the purposes of CIS4.

Product innovation results in the creation of new products, or the improvement of existing ones. These changes may take the form of a good or service[30]. Examples might be the development of a new vaccine (good) or a new customer interface, such as internet banking (services).

Process innovation creates new ways of working, or of creating a good or service[31]. For example, the introduction of the production line, allowing for the specialisation of labour, was a process innovation. An example more pertinent to the services industry might be the creation of a new

[29] DTI (2006) 'Innovation in the UK: Indicators and Insights.'
[30] The definition used by CIS4 is 'bringing to the market or into use by business, new and improved products, including both tangible goods and the provision of services. The degree of innovativeness is shown by the distinction between products new just to the business or which are also new to the market.' DTI (2006) 'Innovation in the UK: Indicators and Insights.' pviii.
[31] The definition used by CIS4 is: 'significant changes in the way that goods or services are produced or provided, again differentiating between processes new to the business only or also new to the industry.' DTI (2006) 'Innovation in the UK: Indicators and Insights.' pviii.

processing system which changes the way that a retail bank, for example, deals with its customers' queries.

Wider innovation refers to changes in management practices, business structure, organisation or marketing strategy. Broader innovation captures all types of innovation, so includes not only enterprises that are product or process innovators, but also those that are wider innovators. Based on these descriptions and the analysis that has been provided above in terms of the nature of innovation in the services industry, it might be expected that London would perform relatively well on the product innovator (services), process innovator and wider innovator categories. This is because these are the types of innovation that might be taking place in the services industry. They are also likely to be the types of innovation that are poorly captured by the government's input measures of innovation (particularly expenditure on R&D), but might be better captured by survey methods such as CIS4.

Table 1: Type of innovation amongst innovation active firms, by region

Percentage of innovation active firms which are:	London	Average rest of UK
Product innovators (goods)	14	16
Product innovators (services)	23	16
Process innovators	17	16
Wider innovators	37	32
Broader innovators	61	60

Source: GLA Economics' calculations based on DTI (2006) 'Innovation in the UK: Indicators and Insights.' p6

Analysis of Table 1 shows that this is indeed the case. London outperforms the average of the rest of the UK not only on product innovators (services) and process innovators, but also on wider innovators and broader innovators.

This then suggests that the type of innovation that is carried out in London does not necessarily require significant R&D spend, and so is not well captured by central government measures. It has been suggested in this paper that this is due to London's industrial structure, since innovation in services is unlikely to be as reliant on R&D spend as that in manufacturing. Table 1 therefore provides some support for this hypothesis, since it shows that London particularly outperforms the other regions of the UK on the measures of innovation which could be expected to best capture innovation in services (product innovator: services, and wider innovator).

Therefore survey data suggests that the government R&D measures of innovation are not particularly effective at capturing innovation, and given its industrial structure, this is particularly the case for London. It is argued that this is because of the dominance of services in London, which, although also the case for the other regional economies of the UK, is relatively greater in London.

4.3 Input and output measures

It has been shown that London's industrial structure, coupled with the nature of innovation in the services industry, means that the government's measures of innovation do not necessarily capture the true extent of innovative activity in the region.

It is argued that this is in large part due to the nature of the measures of innovation used by the government. Three of the four measures used (business expenditure on R&D as a percentage of GVA, gross expenditure on R&D as a percentage of GVA and the percentage of firms with co-operation agreements) look at inputs into the innovation process. Only percentage of turnover from products new to the firm or significantly improved considers *outputs* of the innovation process, in terms of the impacts of that innovation on the firm. This is important if innovation is ultimately of interest because of its link with productivity. If this is the case, then it is the *outputs* of innovation which are truly of interest, since they will feed through to any improvements in productivity.

The characteristics of innovation in the service industry, as set out, mean that it is in fact very difficult to measure inputs to that innovation. Since the majority of government measures are in fact input measures, the dominance of the service sector, especially in London, but to a lesser extent also across the UK as a whole, makes using those measures for analysis of policy design very difficult.

Bearing in mind the distinction between input and output measures, this paper now goes on to consider some alternative measures which might be more suited to measuring innovation in the services sector.

5. A broader range of innovation indicators for London

5.1 Capturing innovation in London

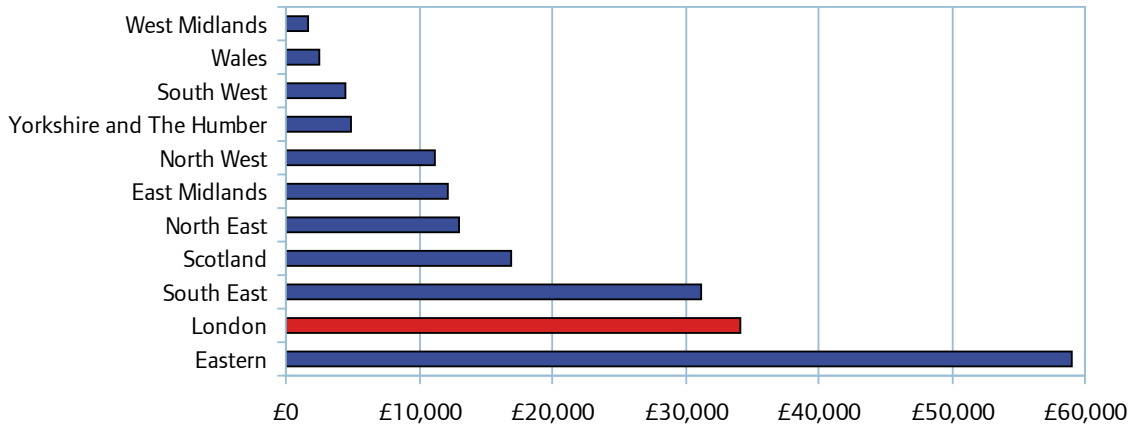
This section considers a wider range of indicators for innovation that might better capture innovative activity in London given the issues discussed so far in this paper. In recognition of the fact that innovation in services is more likely to be driven by the environment in which a business operates, rather than investment in R&D, this section attempts to suggest measures that might be indicative of that environment being in place. In line with the analysis in the previous section, it splits the indicators into two types: input indicators and output indicators.

5.2 Indicators of inputs into innovation

5.2.1. R&D expenditure per worker by sector

Analysing business expenditure on R&D can result in an illustration of differences in industrial structure, rather than differences in the extent of innovative activity, across regions. In order to compensate for these differences in industrial structure across regions, it is suggested that instead of business R&D expenditure as a percentage of GVA, a better measure might be R&D expenditure per worker, in a given industry**.** Although this indicator would remain a measure of inputs into the innovation process, it would allow for greater comparability of those inputs across regions. This approach is illustrated for the chemicals industry in Figure 10, which shows London as the second best performer.

Figure 10: R&D expenditure per worker in chemicals, 2004



Source: GLA Economics' calculations based on data from the Office for National Statistics/Annual Business Inquiry

In theory, the same method could be applied to other R&D intensive industries, such as aerospace, computer and related activities and machinery and equipment. However it should be noted that this could be subject to data limitations, since much of the data on R&D spend by

region is not disclosed, even by broad industry group. Moreover, even if such data were available, it is possible that given that they would be broken down both by region and then by sector within region, they may not be robust enough for statistical analysis.

Moreover, it is important to understand that although this measure may allow for comparison of investment in R&D *across* regions within a given industry, it does not change London's industrial structure. As such, use of this measure will mean that a large proportion of innovative activity in London is left uncaptured. Therefore, there is clearly a need for additional measures.

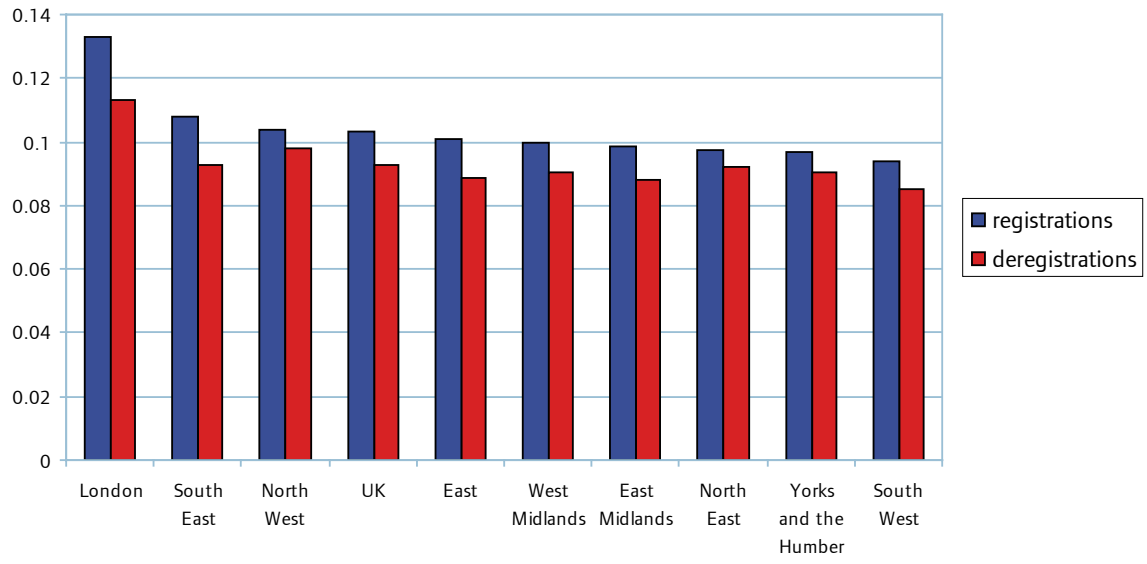
5.2.2 Entrepreneurship

Entrepreneurship is a crucial input to the innovation process. Start-ups bring new products and services to the market, increasing competition and so providing firms with the incentive to innovate to stay one step ahead of their rivals.

VAT registrations and de-registrations provide an indication of entrepreneurship at the regional level by providing some measure, at the very least a proxy measure, of the level of entry and exit to an industry.

Figure 11 shows that London has consistently had the highest number of VAT registrations and de-registrations as a percentage of the current stock of businesses over the period 1994-2004. This gives an indication that entrepreneurship, or entry and exit, in the capital is stronger than anywhere else in the country.

Figure 11: VAT registrations & de-registrations as a percentage of the stock of existing businesses, average 1994-2004



Source: GLA Economics' calculations based on data from the Small Business Service

5.2.3 Human capital

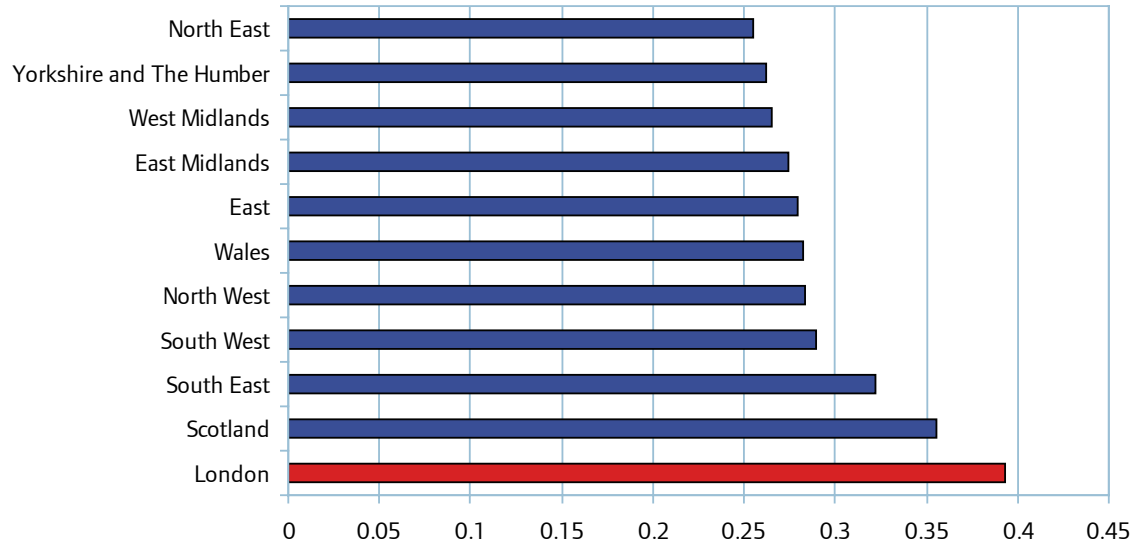
Human capital is a key input into the innovation process, influencing idea creation and the ability to exploit new ideas commercially. It is important here to distinguish between two possible uses of human capital in the innovation process. The first concerns the ability to design new products and processes. It can be argued that the greater the extent of human capital, the more likely a company will be able to create new products and processes. The second concerns the ability to absorb and exploit new ideas. Again, the greater the extent of human capital, the more likely a business will be able to do these things. It is argued that this element of human capital is likely to be of particular importance in services.

Evidence as to the importance of human capital in the innovation process is found in the results of CIS4. The survey found that in innovation active firms, 19 per cent of the workforce was educated to degree level or above. This figure was only nine per cent for non-innovation active firms. Furthermore, the survey provides support for the argument given above, regarding the extra importance of a highly skilled workforce for innovative activity in the services sector. It found that within the knowledge intensive services sector[32], 44 per cent of employees in innovation active firms were educated to degree level or above, compared with just 25 per cent for non-innovation active firms.

Figure 12 shows that if high level skills were used as one of the measures of innovative activity, London would perform the best of all of the UK regions on the basis of the percentage of the workforce with a degree or equivalent. Moreover, it should be noted that this data, taken from the Labour Force Survey, is on a residence basis. It is likely that if the data were collected on a workplace basis, taking not only those that live in London but also those that commute to jobs in the city into account, London would perform even better.

[32] For the purposes of CIS4, the knowledge intensive services sector includes the following sub sectors: telecommunications, financial intermediation, computer and related services, research and development, legal, accounting, book-keeping and auditing activities, tax consultancy, market research and public opinion polling, business and management consultancy, holdings, architectural and engineering activities, and related technical consultancy, technical testing and analysis and advertising. See DTI (2006) 'Innovation in the UK.' DTI Occasional Paper Number 6 – statistical index, definitions table. Available at http://www.dti.gov.uk/files/file33016.xls

Figure 12: Proportion of working age population in employment with degree or equivalent four quarter average June 2004 – May 2005



Source: Labour Force Survey

5.2.4 Agglomeration

Agglomeration refers to the way that activities are stuck together. It provides the opportunity to trade and exchange, as well as to build the institutions that regulate and empower that exchange.[33] It is used to refer to clusters of firms, such as science and technology firms in the Silicon Valley, or financial and business services firms in the City of London.

Agglomeration can be seen as an input into innovation in as much as many firms being located in the same area may create the impetus for more innovation, both because of the intense competition created as a result,[34] and because of the opportunities that are generated for joint working. The degree of agglomeration can be measured using firm density in each region.

[33] See: GLA Economics (2006) 'Why distance doesn't die: Agglomeration and its benefits.' Working Paper 17. p4
[34] See: DTI (2003) ''Innovation Report: Competing in the Global Economy: The Innovation Challenge.'

Table 2: Business density by region, start of 2005

Region	Area (km^2)	Business density (firms per km^2)
North East	8,573	5
North West	14,106	12
Yorkshire and the Humber	15,408	8
East Midlands	15,607	8
West Midlands	12,998	12
East	19,109	10
London	1,572	181
South East	19,069	15
South West	23,837	7
Wales	20,733	4
Scotland	77,907	2
Northern Ireland	13,576	4

Sources: Small Business Service, Office for National Statistics

Table 2 shows that London is unique in having a very high density of businesses compared to the other regions. The 181 firms per km^2 in London is over 12 times higher than the next most densely populated region, the South East. The close proximity of firms in London is likely to lead to more rapid diffusion of innovation than in other parts of the UK.

In addition to the overall density of firms in London, there are areas of the capital where clustering occurs amongst firms from the same business sector. The best example of this is financial firms in the City of London, but others include transportation firms clustered around the Heathrow area and retailers in the West End. Amongst clustered firms in the same sector, the spread of knowledge and innovations is likely to be even more rapid. Therefore a measure which captures the extent of clustering and networks across firms within the same sector would be a helpful additional indicator of innovative activity.

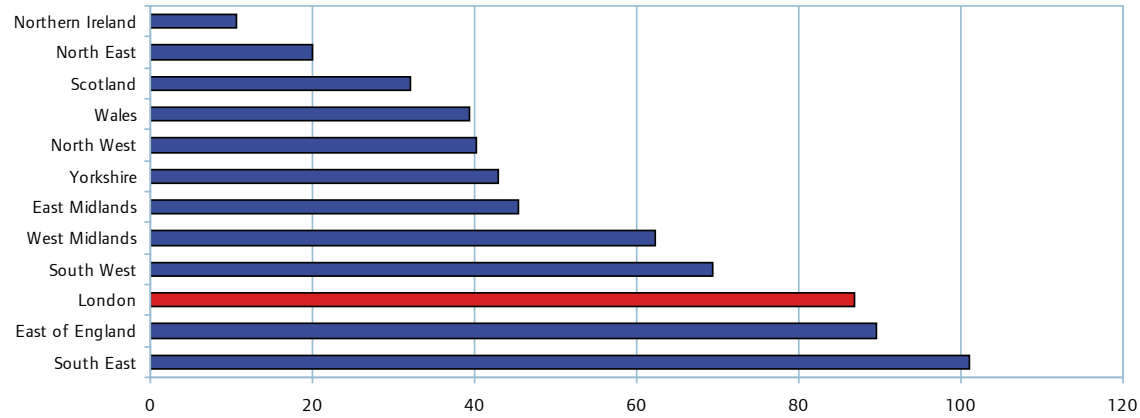
5.3 Indicators of outputs of innovation

5.3.1 Patents

One crucial output from the innovation process that is not included in the central government indicators is intellectual property (IP) (although it is used for international comparisons, see section 3.1). Firms use IP to protect new ideas and practices from being replicated directly by competitors. IP measures therefore clearly capture an output of the innovation process: the ideas that are created by it. The most commonly used measure of IP is patents per head of the population.

Figure 13 shows that in 2004 the number of patents registered per head of the population in London was the third highest of the UK regions. It should be noted however, that a significant number of firms in London may choose to register their patents in other countries. If firms in London are more likely than firms elsewhere in the UK to do this, then this measure may be biased towards underestimating innovation in London. It could be asserted that this may well be the case given the international nature of many of London's firms.

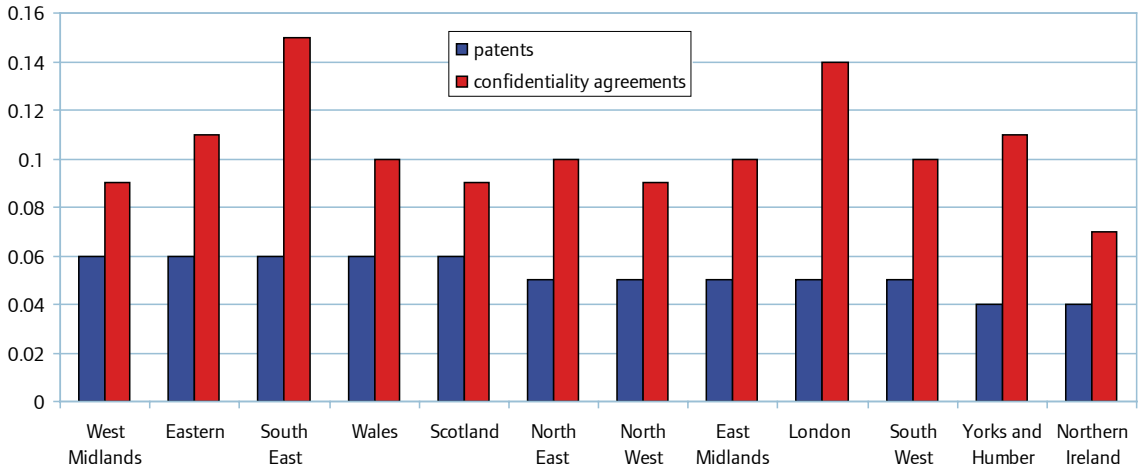
Figure 13: Number of patents granted per million of population, 2004



Source: The Patent Office

In addition, it seems possible that due to the nature of the industrial structure in London, firms are less likely to use patents per se, regardless of the country in which they are registered. Data from CIS4 allow for analysis of this hypothesis. The survey asked respondents about the relative importance that they placed on various different methods of protecting their IP. Some of the results are illustrated in Figure 14.

Figure 14: Percentage of firms reporting different methods of IP protection as being of high importance to them



Source: DTI/CIS 4[35]

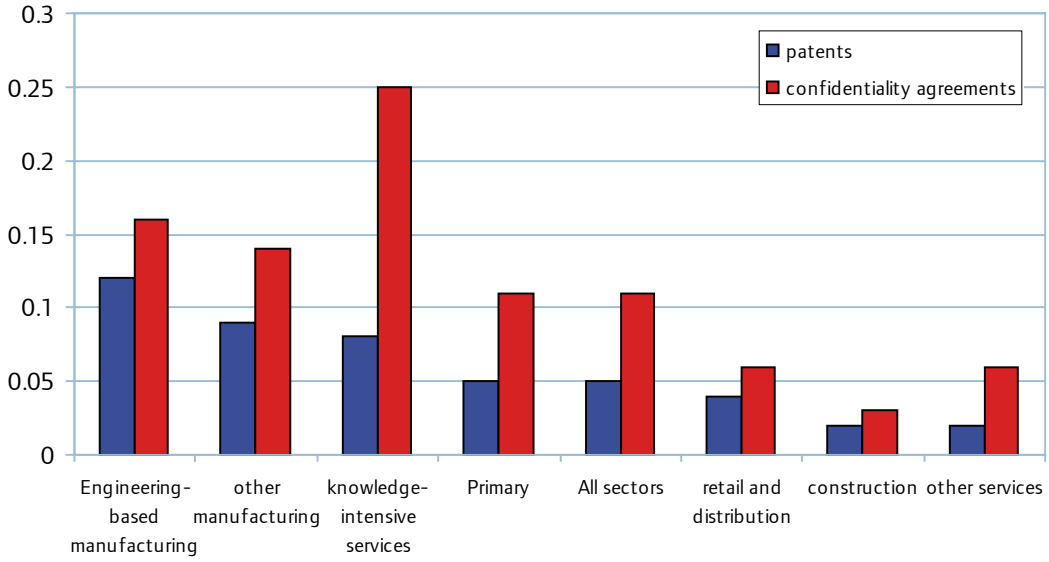
Figure 14 shows the percentage of all firms that reported patents and confidentiality agreements respectively as being of high importance in protecting their IP. It shows that although only five per cent of firms in London reported patents as such, a much greater percentage (14 per cent) reported that confidentiality agreements were important for protecting their IP. Moreover, whilst the percentage of firms reporting patents as being of high importance was lower in London than in many of the other regions of the UK, the percentage of firms reporting confidentiality agreements as being of high importance was higher in London than in all other regions except the South East.

It seems possible that this is because patenting is more suited to knowledge that is generated through investing in R&D and creating individual innovations. If so, then it is possible that the type of innovation that takes place in the services industry (and so in London) may not be particularly suited to patenting. If this is the case, then the number of patents may fail to capture much of the innovation taking place in London.

This issue can be further explored by considering the relative importance of patents and other methods of IP protection across firms in different sectors. This is illustrated in Figure 15.

[35] DTI (2006) 'Innovation in the UK.' DTI Occasional Paper Number 6 – statistical index. Available at http://www.dti.gov.uk/files/file33016.xls

Figure 15: Percentage of firms across different sectors reporting various different methods of IP protection as being of high importance



Source: DTI/CIS 4[36]

Figure 15 provides support for the argument that the extent of patenting in London is driven by its industrial structure. It shows that a relatively low proportion of firms in the services industries (both knowledge intensive services and other services) consider patents as being of high importance in protecting their IP. By contrast, it also shows that a much greater proportion of firms in the knowledge intensive services sector place high importance on confidentiality agreements as a way of protecting their IP. This underlines the point already made concerning the nature of IP in London.

As such, analysis from CIS4 has illustrated the weaknesses of using patents as a measure of innovative activity in London. Nonetheless, IP is an important output measure of innovation, and patents are a measure of IP that is available at the regional level. Therefore it is argued that patents per head *should* be used as an indicator of innovation across the UK regions despite these weaknesses. However, it is important that this measure is not used in isolation, but is instead considered as part of the wider picture of the nature of innovation across the regions, for instance, alongside a consideration of confidentiality agreements.

5.3.2. Articles published in Scientific Journals

Articles published in scientific journals can be considered as an output measure of innovation, since it documents what has been generated by innovative activity. However, it is argued that

[36] DTI (2006) 'Innovation in the UK.' DTI Occasional Paper Number 6 – statistical index. Available at http://www.dti.gov.uk/files/file33016.xls

including this as an additional indicator would not add significantly to the analysis of the amount of innovative activity being undertaken. This is because of the type of innovation that this measure is likely to capture. As has been explained, in relation to the business enterprise research and development measure, this measure is likely to capture the type of product innovation (in goods rather than services) that is perhaps more typical of the type of investment that takes place in the manufacturing sector. This is especially the case given the fact that this measure concerns publications in *scientific* journals.

5.4. Survey Measures

Survey measures directly ask partaking firms about the amount of innovative activity that they are undertaking. As such, they overcome the issues discussed, surrounding the extent to which other measures capture *all* kinds of innovation. In theory, if a firm is undertaking any kind of innovative activity, then it will be reported in the survey. This will capture innovation such as changes in working practices and marketing strategies as well as investment in research and development and new equipment.

In this way, survey measures are able to capture both inputs to, and outputs from, the innovation process. For example, the Fourth Community Innovation Survey, which has been analysed in this paper, asks firms to report on inputs such as number of co-operation agreements on innovation, as well as asking firms whether they are 'innovation active.' The survey also asks firms about the impacts of their innovation, including impact on turnover. Moreover, by asking firms directly if they are partaking in innovation, the survey is able to distinguish between different types of innovation, such as product innovation, process innovation, and wider innovation (see section 4.2 for definitions).

It is therefore clear that in a services dominated economy, survey measures are likely to be the most effective way of capturing innovation that is being undertaken throughout the economy, and as such will allow for comparison of innovative performance both across industries, and across regions of the UK, regardless of industrial structure.

The effective use of survey measures is very much reliant on the definition used within the survey, and the way that it is interpreted by those taking part. It is important that the definition used is wide enough and explicit enough for firms that are undertaking activities that might not traditionally be thought of as innovation to understand that they are in fact innovation active for the purposes of the survey.

6. Conclusions

This paper has found that there is in fact no real paradox as regards London's innovation performance. Although it has a mixed performance against central government's measures of innovation in the regions, this seems to be largely driven by its industrial structure and the difficulty of capturing inputs to innovation in the services sector. Moreover, London performs well against output measures of innovation, and is the most productive of all the regions of the UK.

One of the principle reasons why central government is interested in the level of innovation in each of the regions is because innovation has been identified as a driver of productivity. Since it is the outputs of innovation that would be expected to feed through to increases in productivity, in the context of London's strong performance against output measures, its weaker performance against input measures is less of a concern.

Innovation in services is likely to be driven to a large extent by the environment in which the business operates, rather than by specific measurable inputs such as investment in research and development. This environment is likely to be dynamic, driven by factors such as the number of competitors located within close geographical proximity, and the demands of the customer base. These types of concepts are relatively difficult to capture in simple input measures, thus leading to the difficulties of capturing inputs to innovation in London.

As such, this paper has argued that in an increasingly services-dominated economy, the most effective way of capturing all innovative activity will be through survey measures. This is open to the caveat that the survey must define innovative activity in an open and explicit enough manner for all firms to interpret it in the same way.

In terms of understanding the extent of innovative activity in an economy, analysis of output measures, which will tend to be more accurate because of the difficulties in measuring inputs, will be most appropriate. It is understood however, that in terms of designing policy, it may well be necessary to have a better understanding of the inputs to the innovation process. With particular relevance to the London economy, this will mean gaining an appreciation of what creates the environment that encourages firms to innovate. There may well be a need for more research into this area in order to ensure that these issues are fully understood.

Glossary of terms

ABI	Annual Business Enquiry
BERD	Business Enterprise Research and Development
CIS3	Third Community Innovation Survey
CIS4	Fourth Community Innovation Survey
DTI	Department for Trade and Industry
GERD	Gross Expenditure on Research and Development
HEI	Higher Education Institute
HESA	Higher Education Statistics Agency
IDBR	Inter-Departmental Business Register
IP	Intellectual Property
ONS	Office for National Statistics
PNP	Private Non-Profit
R&D	Research and Development
SBS	Small Business Service

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Chinese

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Vietnamese

Nếu bạn muốn có văn bản tài liệu
này bằng ngôn ngữ của mình, hãy
liên hệ theo số điện thoại hoặc địa
chỉ dưới đây.

Greek

Αν θέλετε να αποκτήσετε αντίγραφο του παρόντος εγγράφου στη δική σας γλώσσα, παρακαλείστε να επικοινωνήσετε τηλεφωνικά στον αριθμό αυτό ή ταχυδρομικά στην παρακάτω διεύθυνση.

Turkish

Bu belgenin kendi dilinizde
hazırlanmış bir nüshasını
edinmek için, lütfen aşağıdaki
telefon numarasını arayınız

Punjabi

ਜੇ ਤੁਹਾਨੂੰ ਇਸ ਦਸਤਾਵੇਜ਼ ਦੀ ਕਾਪੀ ਤੁਹਾਡੀ ਆਪਣੀ ਭਾਸ਼ਾ ਵਿਚ ਚਾਹੀਦੀ ਹੈ, ਤਾਂ ਹੇਠ ਲਿਖੇ ਨੰਬਰ 'ਤੇ ਫ਼ੋਨ ਕਰੋ ਜਾਂ ਹੇਠ ਲਿਖੇ ਪਤੇ 'ਤੇ ਰਾਬਤਾ ਕਰੋ:

Hindi

यदि आप इस दस्तावेज की प्रति अपनी
भाषा में चाहते हैं, तो कृपया निम्नलिखित
नंबर पर फोन करें अथवा नीचे दिये गये
पते पर संपर्क करें

Bengali

আপনি যদি আপনার ভাষায় এই দলিলের প্রতিলিপি
(কপি) চান, তা হলে নীচের ফোন্ নম্বরে
বা ঠিকানায় অনুগ্রহ করে যোগাযোগ করুন।

Urdu

اگر آپ اِس دستاویز کی نقل اپنی زبان میں
چاھتے ھیں، تو براہ کرم نیچے دئے گئے نمبر
پر فون کریں یا دیئے گئے پتے پر رابطہ کریں

Arabic

إذا أردت نسخة من هذه الوثيقة بلغتك، يرجى
الاتصال برقم الهاتف أو مراسلة العنوان
أدناه

Gujarati

જો તમને આ દસ્તાવેજની નકલ તમારી ભાષામાં
જોઇતી હોય તો, કૃપા કરી આપેલ નંબર ઉપર
ફોન કરો અથવા નીચેના સરનામે સંપર્ક સાધો.